IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Robert A. Cochran, et al.	Examiner: James R. Golden
Serial No.:	10/798,962	Group Art Unit: 2187
Filed:	March 12, 2004	Docket No.: 10019728-1
Title:	Data Synchronization for Two Data Mirrors with Sidefiles	

APPEAL BRIEF UNDER 37 C.F.R. § 41.37

Mail Stop Appeal Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This Appeal Brief is filed in response to the Final Office Action mailed November 2, 2006 and Notice of Appeal filed February 2, 2007.

AUTHORIZATION TO DEBIT ACCOUNT

It is believed that no extensions of time or fees are required, beyond those that may otherwise be provided for in documents accompanying this paper. However, in the event that additional extensions of time are necessary to allow consideration of this paper, such extensions are hereby petitioned under 37 C.F.R. § 1.136(a), and any fees required (including fees for net addition of claims) are hereby authorized to be charged to Hewlett-Packard Development Company's deposit account no. 08-2025.

I. REAL PARTY IN INTEREST

The real party in interest is Hewlett-Packard Development Company, LP, a limited partnership established under the laws of the State of Texas and having a principal place of business at 20555 S.H. 249 Houston, TX 77070, U.S.A. (hereinafter "HPDC"). HPDC is a Texas limited partnership and is a wholly-owned affiliate of Hewlett-Packard Company, a Delaware Corporation, headquartered in Palo Alto, CA. The general or managing partner of HPDC is HPQ Holdings, LLC.

II. RELATED APPEALS AND INTERFERENCES

There are no known related appeals or interferences known to appellant, the appellant's legal representative, or assignee that will directly affect or be directly affected by or have a bearing on the Appeal Board's decision in the pending appeal.

III. STATUS OF CLAIMS

Claims 1 – 32 stand finally rejected. The rejection of claims 1 – 32 is appealed.

IV. STATUS OF AMENDMENTS

No amendments were made after receipt of the Final Office Action. All amendments have been entered.

V. SUMMARY OF CLAIMED SUBJECT MATTER

The following provides a concise explanation of the subject matter defined in each of the claims involved in the appeal, referring to the specification by page and line number and to the drawings by reference characters, as required by 37 C.F.R. § 41.37(c)(1)(v). Each element of the claims is identified by a corresponding reference to the specification and drawings where applicable. Note that the citation to passages in the specification and drawings for each claim element does not imply that the limitations from the specification and drawings should be read into the corresponding claim element or that these are the sole sources in the specification supporting the claim features.

The Summary of the Invention section provides the following summary at paragraph [0007]: At least one embodiment of the present invention provides a data synchronization method for a redundant data storage arrangement in which there are at least a primary storage entity and mirroring first and second remote storage entities in communication therewith, respectively, writes to the first and second remote storage entities being tracked via respective first and second sidefiles, the first and second storage entities having different levels of write-currency relative to each other. Such a method may include: comparing the first sidefile with the second sidefile; and updating writes stored at the second remote storage entity based upon the comparison of the first and second sidefiles.

Claim 1

A data synchronization method for a redundant data storage arrangement in which there are at least a primary storage entity and mirroring first and second remote storage entities in communication therewith, respectively, writes to the first and second remote storage entities being tracked via respective first and second sidefiles, the first and second storage entities having different levels of write-currency relative to each other, the method comprising [0018-0022]:

receiving acknowledgements from the second remote storage entity at both the primary storage entity and the first remote storage entity [0034-0035];

comparing acknowledgements and sequence numbers in the first sidefile with acknowledgements and sequence numbers in the second sidefile (Figs. 2A, 2B: [0034-0036, 0044]); and

updating writes stored at the second remote storage entity based upon the comparison of the first and second sidefiles [0039] .

Claim 13

A redundant data storage arrangement comprising:

a primary storage entity (#10) to (1) forward writes to each of a mirroring first and second remote storage entity (#s 20, 30) and (2) forward acknowledgements from the second remote storage entity to the first remote storage entity [0024, 0035];

the mirroring first remote storage entity, in communication with the primary storage entity, which includes a first sidefile (#22) via which writes forwarded from the primary storage entity are tracked [0027, 0032]; and

the mirroring second remote storage entity, in communication with the primary storage entity, which includes a second sidefile (#32) via which writes forwarded from the primary storage are tracked [0027, 0032];

the first and second storage entities having different levels of write-currency relative to each other [0024];

an initiating one of the first and second remote storage entities being operable

to compare acknowledgements and sequence numbers in the first and second sidefiles (Figs. 2A, 2B: [0034-0036, 0044]), and

invoke an updating of writes stored at the second remote storage entity based upon the comparison of the first and second sidefiles [0039].

Claim 28

A data synchronization method for a redundant data storage arrangement in which there are at least a primary storage entity and mirroring first and second remote storage entities in communication therewith, respectively, the method comprising:

synchronously receiving writes at the first remote storage entity that have been forwarded from the primary storage entity [0228]; and

maintaining a sidefile via which are tracked items that include [0027]

acknowledgements from the second remote storage entity received at both the primary storage entity and the first remote storage entity (Figs. 2A, 2B: [0034-0036, 0044]),

sequence numbers assigned to writes [0029],

writes received at the first remote storage entity [0027, 0031, 0036], and

writes received at the second remote storage entity [0027, 0033].

Claim 29

A mirroring first remote storage entity for a redundant data storage arrangement in which there are at least the first remote storage entity (#22) and a primary storage

entity (#10) in communication therewith, and a mirroring second remote storage entity (#30) in communication with the primary storage entity, respectively, the first remote storage entity comprising:

memory to store data [0050]; and

a processor operable [0050] to

synchronously receive writes that have been forwarded from the primary storage entity [0024]; and

maintain a sidefile in the memory via which are tracked items that include [0027]

acknowledgements from the second remote storage entity received at both the primary storage entity and the first remote storage entity (Figs. 2A, 2B: [0034-0036, 0044]),

sequence numbers assigned to writes [0029],

writes received at the first remote storage entity [0027, 0031, 0036], and

writes received at the second remote storage entity [0027, 0033].

Claim 30

A data synchronization method for a redundant data storage arrangement in which there a primary storage entity and mirroring first and second remote storage entities in communication therewith, respectively, the method comprising:

synchronously forwarding to the first remote storage entity writes from the primary storage entity [0024];

informing the first remote storage entity regarding writes acknowledged to have been received at the second remote storage entity [0034-0035]; and

comparing (1) the writes acknowledged to have been received and (2) sequence numbers assigned to the writes to determine data content at the second remote storage entity (Figs. 2A, 2B: [0034-0036, 0044]).

Claim 31

A primary storage entity for a redundant data storage arrangement in which there are at least the primary storage entity and mirroring first and second remote storage entities in communication therewith, respectively, the primary storage entity comprising:

memory to store data [0050]; and

a processor operable to [0050]

synchronously forward writes to the first remote storage entity [0024];

receive indications of writes acknowledged to have been received at the second remote storage entity [0024];

inform the first remote storage entity regarding the indications [0034-0035];

assign sequence numbers to writes [0029]; and

send the sequence numbers to the first and second remote storage entities [0031].

Claim 32

A redundant data storage arrangement comprising:

primary storage means (#10) for storing writes received from a host (#5, [0024]);

first remote mirror means (#20) for mirroring writes forwarded from the primary storage means and for tracking such writes via a first sidefile (#22, [0027, 0032]); and

second remote mirror means (#30) for mirroring writes forwarded from the primary storage means and for tracking writes such writes via a second sidefile (#32, [0027, 0032]);

the first and second storage entities having different levels of write-currency relative to each other [0027, 0032];

the first sidefile including (1) sequence numbers assigned to writes and (2) acknowledgements from the second remote mirror means [0029, 0031];

the second sidefile including sequence numbers assigned to writes [0029, 0031];

comparison means, responsive to the primary storage means being rendered inoperative, for comparing the first and second sidefiles (Figs. 2A, 2B: [0034-0036, 0044]), and

update means, responsive to the comparison, for updating writes stored at the second remote mirror means based upon the comparison of the first and second sidefiles [0039].

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Claims 1 – 27 are rejected under 35 USC § 112, second paragraph, as failing to comply with the written description requirement.

Claims 1-4, 6, 13-17, 19, and 26-33 are rejected under 35 USC § 102(e) as being anticipated by USPN 2005/0038968 (Iwamura).

Claims 5 and 18 are rejected under 35 USC § 103(a) as being unpatentable over Iwamura in view of USPN 6,912,483 (Frederick).

Claims 7-9 and 20-22 are rejected under 35 USC § 103(a) as being unpatentable over Iwamura in view of USPN 6,260.125 (McDowell).

Claims 10-12 and 23-25 are rejected under 35 USC § 103(a) as being unpatentable over Iwamura in view of USPN 6,098.179 (Harter).

VII. ARGUMENT

The rejection of claims 1 – 32 is improper, and Applicants respectfully requests withdraw of this rejection.

The claims do not stand or fall together. Instead, Applicants present separate arguments for various independent and dependent claims. Each of these arguments is separately argued below and presented with separate headings and sub-heading as required by 37 C.F.R. § 41.37(c)(1)(vii).

Claim Rejections: 35 USC § 112

Claims 1 – 27 are rejected under 35 USC § 112, first paragraph, as failing to comply with the written description requirement. Specifically, the Examiner argues that the recitation "comparing acknowledgements in the first sidefile with acknowledgements in the second side file" was not described in the specification in such a way as to reasonably convey to one skilled that the inventors had possession of this claimed invention. Applicants respectfully disagree.

Under 35 U.S.C. § 112, first paragraph, the test for establishing an adequate written description concerns showing evidence that the inventors had possession of the claimed invention. As has been repeatedly stated by both the Court of Customs and Patent Appeals and the Federal Circuit:

> [A]ll that is required is that it [the applicant] *reasonably conveyed* to persons skilled in the art that, as of the filing date thereof, the inventor had *possession* of the subject matter later claimed by him. (See *Eiselstein*, 52 F.3d at 1039, 34 USPQ2d 1467, 1470 (emphasis added)).

The issue is: Does Applicants' specification reasonably convey to one skilled in the art possession of the recitation "comparing acknowledgements in the first sidefile with acknowledgements in the second side file?" It does.

First, figure 2A shows a table of a sidefile for a primary storage device. In this table, column 47 shows acknowledgements received from a second storage device (see paragraph [0034]). Column 48 shows acknowledgements received at the first storage device (see paragraph [0035]). The table of figure 2A provides a side-by-side comparison of acknowledgements in column 47 and 48. One skilled in the art can visually see a comparison of information presented in a table of side-by-side columns.

Second, paragraph [0044] in the original specification even discusses making comparisons between the sidefiles shown in figures 2A, 2B, 2C:

> Next at block 504, sidefile 22 is compared with sidefile 32. Next at block 506, based upon the comparison between sidefiles 22 and 32, it is identified which writes need to be sent from first remote storage 20 to second remote storage 30 in order to make second remote storage 30 write-current relative to first remote storage 20. As noted above, the comparison is conducted by first remote storage 20, but it is well within the scope of at least one embodiment of the present information for second remote storage 30 alternatively to conduct the comparison. (See paragraph [0044]).

Clearly, paragraph [0044] expressly discusses making comparisons of sidefiles. Figures 2A, 2B, and 2C show sidefiles in the form of tables so data is visually presented in side-by-side columns. Applicants believe that one skilled in the art would read the entire specification (including paragraph [0044]) and understand the sidefile tables of figure 2A, 2B, and 2C showing visual comparisons of data. The specification and drawings reasonably convey to one skilled in the art "comparing acknowledgements in the first sidefile with acknowledgements in the second side file."

Claim Rejections: 35 USC § 102(e)

Claims 1-4, 6, 13-17, 19, and 26-33 are rejected under 35 USC § 102(e) as being anticipated by USPN 2005/0038968 (Iwamura). Applicants respectfully traverse these rejections.

A proper rejection of a claim under 35 U.S.C. §102 requires that a single prior art reference disclose each element of the claim. See MPEP § 2131, also, *W.L. Gore & Assoc., Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 U.S.P.Q. 303, 313 (Fed. Cir. 1983). Since Iwamura neither teaches nor suggests each element in the claims, these claims are allowable over Iwamura. Some examples for the independent claims are provided below.

Iwamura uses logs stored in a log storage area to perform a rollback for database recovery ([0257]). The logs and rollback are based on time: "Accordingly, when the database is recovered, the host 110 starts the recovery processing from the log at this time" ([0235]). Iwamura does mention an alternative embodiment wherein a sequential ID is used: "Here, the case of the ID has a feature that if a rule is set such that continuous numbers are previously assigned, a missing number can be recognized" ([0236]). **Iwamura does not teach or suggest using acknowledgements as part of his rollback process for database recovery.**

Claim 1

By way of example, claim 1 recites "receiving acknowledgements from the second remote storage entity at both the primary storage entity and the first remote storage entity." Iwamura does not teach that acknowledgements from the secondary sites (i.e., the sync site or async site) are sent to both the primary site and a secondary site.

For at least these reasons, claim 1 and its dependent claims are allowable over Iwamura.

As another example, claim 1 recites "comparing acknowledgements and sequence numbers in the first sidefile with acknowledgements and sequence numbers in the second sidefile." As noted above, Iwamura uses logs based on time and mentions the use of continuous numbers as an alternative. Iwamura, though, never teaches or suggests comparing both acknowledgements and sequence numbers as recited in claim 1.

For at least these reasons, claim 1 and its dependent claims are allowable over Iwamura.

Claim 13

By way of example, claim 13 recites a primary storage entity to "forward acknowledgements from the second remote storage entity to the first remote storage entity." Iwamura does not teach that acknowledgements from the async site are forwarded to the sync site.

For at least these reasons, claim 13 and its dependent claims are allowable over Iwamura.

As another example, claim 13 recites comparing both "acknowledgements and sequence numbers in the first and second sidefiles." As noted above, Iwamura uses logs based on time and mentions the use of continuous numbers as an alternative. Iwamura, though, never teaches or suggests comparing both acknowledgements and sequence numbers as recited in claim 13.

For at least these reasons, claim 13 and its dependent claims are allowable over Iwamura.

Claims 28 and 29

By way of example, claims 28 and 29 recite maintaining a sidefile that includes "acknowledgements from the second remote storage entity received at both the primary storage entity and the first remote storage entity." Iwamura does not teach that acknowledgements from the secondary sites (i.e., the sync site or async site) are sent to both the primary site and a secondary site.

For at least these reasons, claims 28 and 29 and their dependent claims are allowable over Iwamura.

Claim 30

By way of example, claim 30 recites "comparing (1) the writes acknowledged to have been received and (2) sequence numbers assigned to the writes to determine data content at the second remote storage entity." As noted above, Iwamura uses logs based on

time and mentions the use of continuous numbers as an alternative. Iwamura, though, never teaches or suggests comparing both acknowledgements and sequence numbers as recited in claim 30.

For at least these reasons, claim 30 is allowable over Iwamura.

Claim 31

By way of example, claim 31 recites a processor that is operable to "receive indications of writes acknowledged to have been received at the second remote storage entity." The claim then recites that the processor is operable to "assign sequence numbers to writes; and send the sequence numbers to the first and second remote storage entities." As noted above, Iwamura uses logs based on time and mentions the use of continuous numbers as an alternative. Iwamura, though, never teaches or suggests the recitations of claim 31.

For at least these reasons, claim 31 is allowable over Iwamura.

Claim 32

By way of example, claim 32 recites that the first sidefile includes "acknowledgements from the second remote mirror means" Iwamura does not teach that acknowledgements from the secondary sites (i.e., the sync site or async site) are sent to both the primary site and a secondary site.

For at least these reasons, claim 32 is allowable over Iwamura.

As another example, claim 32 recites that the first sidefile includes both sequence numbers and acknowledgements. The second sidefile also includes sequence numbers. A comparison means compares the first and second sidefiles. As noted above, Iwamura uses logs based on time and mentions the use of continuous numbers as an alternative. Iwamura, though, never teaches or suggests comparing both acknowledgements and sequence numbers as recited in claim 32.

For at least these reasons, claim 32 is allowable over Iwamura.

Claim Rejections: 35 USC § 103(a)

Claims 5 and 18 are rejected under 35 USC § 103(a) as being unpatentable over Iwamura in view of USPN 6,912,483 (Frederick). As noted above, Iwamura does not teach or suggest all the elements of independent claims 1 and 13. Frederick does not cure the deficiencies of Iwamura. For at least these reasons, claims 5 and 18 are allowable over Iwamura and Frederick.

Claim Rejections: 35 USC § 103(a)

Claims 7-9 and 20-22 are rejected under 35 USC § 103(a) as being unpatentable over Iwamura in view of USPN 6,260,125 (McDowell). As noted above, Iwamura does not teach or suggest all the elements of independent claims 1 and 13. McDowell does not cure the deficiencies of Iwamura. For at least these reasons, claims 7-9 and 20-22 are allowable over Iwamura and McDowell.

Claim Rejections: 35 USC § 103(a)

Claims 10-12 and 23-25 are rejected under 35 USC § 103(a) as being unpatentable over Iwamura in view of USPN 6,098,179 (Harter). As noted above, Iwamura does not teach or suggest all the elements of independent claims 1 and 13. Harter does not cure the deficiencies of Iwamura. For at least these reasons, claims 10-12 and 23-25 are allowable over Iwamura and Harter.

CONCLUSION

In view of the above, Applicants respectfully request the Board of Appeals to reverse the Examiner's rejection of all pending claims.

Any inquiry regarding this Amendment and Response should be directed to Philip S. Lyren at Telephone No. 832-236-5529. In addition, all correspondence should continue to be directed to the following address:

Hewlett-Packard Company
Intellectual Property Administration
P.O. Box 272400
Fort Collins, Colorado 80527-2400

Respectfully submitted,

/Philip S. Lyren #40,709/

Philip S. Lyren
Reg. No. 40,709
Ph: 832-236-5529

VIII. Claims Appendix

1. A data synchronization method for a redundant data storage arrangement in which there are at least a primary storage entity and mirroring first and second remote storage entities in communication therewith, respectively, writes to the first and second remote storage entities being tracked via respective first and second sidefiles, the first and second storage entities having different levels of write-currency relative to each other, the method comprising:

receiving acknowledgements from the second remote storage entity at both the primary storage entity and the first remote storage entity;

comparing acknowledgements and sequence numbers in the first sidefile with acknowledgements and sequence numbers in the second sidefile; and

updating writes stored at the second remote storage entity based upon the comparison of the first and second sidefiles.

2. The method of claim 1, wherein the updating of writes includes forwarding to the second remote storage entity writes that are present in the first sidefile but not yet present in the second sidefile.

3. The method of claim 1, wherein the comparing is done on the basis of sequence numbers associated with the writes.

4. The method of claim 1, further comprising:

establishing a communication connection between the first and second remote storage entities in response to the primary storage entity becoming inoperative;

wherein the comparing and updating are also performed in response to the primary storage entity becoming inoperative.

5. The method of claim 1, further comprising:

configuring the first and second sidefiles to store a fixed number of writes therein, respectively; and

adding a new write to the first and second sidefiles by overwriting the oldest write therein, respectively.

6. The method of claim 1, further comprising:

adaptively adjusting the number of writes that can be stored in the first sidefile.

7. The method of claim 6, wherein the adaptive adjustment is based upon the writes that are stored in the second sidefile.

8. The method of claim 7, wherein the adaptive adjustment more particularly is based upon the write stored in the second sidefile which has the oldest contiguous sequence number.

9. The method of claim 7, further comprising:

identifying at least some of the writes stored in the second sidefile; and then

accordingly informing the first remote storage entity regarding such identities.

10. The method of claim 1, further comprising:

configuring the first sidefile to include a field that is used to track whether a write has been acknowledged by the second remote storage entity as having been received.

11. The method of claim 1, further comprising:

providing a third sidefile via which writes received thereby are tracked; and

configuring the third sidefile to include a field that is used to track whether a write has been acknowledged by the second remote storage entity as having been received.

12. The method of claim 11, further comprising:

configuring the third sidefile further to include a field that is used to track whether a write-acknowledgement forwarded from the second remote storage entity has been acknowledged as having been received by the first remote storage entity.

13. A redundant data storage arrangement comprising:

a primary storage entity to (1) forward writes to each of a mirroring first and second remote storage entity and (2) forward acknowledgements from the second remote storage entity to the first remote storage entity;

the mirroring first remote storage entity, in communication with the primary storage entity, which includes a first sidefile via which writes forwarded from the primary storage entity are tracked; and

the mirroring second remote storage entity, in communication with the primary storage entity, which includes a second sidefile via which writes forwarded from the primary storage are tracked;

the first and second storage entities having different levels of write-currency relative to each other;

an initiating one of the first and second remote storage entities being operable

to compare acknowledgements and sequence numbers in the first and second sidefiles, and

invoke an updating of writes stored at the second remote storage entity based upon the comparison of the first and second sidefiles.

14.The redundant data storage arrangement of claim 13, wherein the updating is performed by the first remote storage entity, which is operable to do so by forwarding to the second remote storage entity writes that are present in the first sidefile but not yet present in the second sidefile.

15. The redundant data storage arrangement of claim 13, wherein each of the first and second remote storage entities is operable to

preserve in the respective sidefile sequence numbers associated with the writes; and

sort the respective sidefile according to the sequence numbers.

16. The redundant data storage arrangement of claim 13, wherein:

the initiating one is further operable to establish a communication connection between itself and the other remote storage entity in response to the primary storage entity becoming inoperative; and

the comparison and the update are performed in response to the primary storage entity becoming inoperative.

17. The redundant data storage arrangement of claim 13, wherein the first remote storage entity is closer in proximity to the primary storage entity than the second remote storage entity.

18. The redundant data storage arrangement of claim 13, wherein:

the first and second sidefiles are configured to store a fixed number of writes therein, respectively; and

the first and second remote storage entities are operable to add a new write to the first and second sidefiles by overwriting the oldest write therein, respectively.

19. The redundant data storage arrangement of claim 13, wherein:

the first remote storage entity is operable to adaptively adjust the number of writes that can be stored in the first sidefile.

20. The redundant data storage arrangement of claim 19, wherein the adaptive adjustment is based upon the writes are stored in the second sidefile.

21. The redundant data storage arrangement of claim 20, wherein the adaptive adjustment more particularly is based upon the write stored in the second sidefile which has the newest contiguous sequence number.

22. The redundant data storage arrangement of claim 20, wherein:

the primary storage entity is operable to identify at least some of the writes stored in the second sidefile and then accordingly inform the first remote storage entity regarding such identities.

23. The redundant data storage arrangement of claim 13, wherein:

the first sidefile includes a field that is used to track whether a write has been acknowledged by the second remote storage entity as having been received.

24. The redundant data storage arrangement of claim 13, wherein:

the primary storage entity includes a third sidefile to track writes received thereby:

the first sidefile including a field that is used to track whether a write has been acknowledged by the second remote storage entity as having been received.

25. The redundant data storage arrangement of claim 24, wherein the first sidefile further includes a field that is used to track whether a write-acknowledgement forwarded from the second remote storage entity has been acknowledged as having been received by the first remote storage entity.

26. The redundant data storage arrangement of claim 13, wherein each of the first and second remote storage entities represents a tracked write in the first and second sidefile, respectively, with: location information as to where on a physical medium the write is to be performed; actual data associated with the write that is to be written to the physical medium; and a sequence number uniquely associated with the write.

27. The redundant data storage arrangement of claim 13, wherein:

the first remote storage entity receives writes forwarded synchronously from the primary storage entity; and

the second remote storage entity receives writes forwarded asynchronously from the primary storage entity.

28. A data synchronization method for a redundant data storage arrangement in which there are at least a primary storage entity and mirroring first and second remote storage entities in communication therewith, respectively, the method comprising:

synchronously receiving writes at the first remote storage entity that have been forwarded from the primary storage entity; and

maintaining a sidefile via which are tracked items that include

acknowledgements from the second remote storage entity received at both the primary storage entity and the first remote storage entity,

sequence numbers assigned to writes,

writes received at the first remote storage entity, and

writes received at the second remote storage entity.

29. A mirroring first remote storage entity for a redundant data storage arrangement in which there are at least the first remote storage entity and a primary storage entity in communication therewith, and a mirroring second remote storage entity in communication with the primary storage entity, respectively, the first remote storage entity comprising:

memory to store data; and

a processor operable to

synchronously receive writes that have been forwarded from the primary storage entity; and

maintain a sidefile in the memory via which are tracked items that include

acknowledgements from the second remote storage entity received at both the primary storage entity and the first remote storage entity,

sequence numbers assigned to writes,

writes received at the first remote storage entity, and

writes received at the second remote storage entity.

30. A data synchronization method for a redundant data storage arrangement in which there a primary storage entity and mirroring first and second remote storage entities in communication therewith, respectively, the method comprising:

synchronously forwarding to the first remote storage entity writes from the primary storage entity;

informing the first remote storage entity regarding writes acknowledged to have been received at the second remote storage entity; and

comparing (1) the writes acknowledged to have been received and (2) sequence numbers assigned to the writes to determine data content at the second remote storage entity.

31. A primary storage entity for a redundant data storage arrangement in which there are at least the primary storage entity and mirroring first and second remote storage entities in communication therewith, respectively, the primary storage entity comprising:

memory to store data; and

a processor operable to

synchronously forward writes to the first remote storage entity;

receive indications of writes acknowledged to have been received at the second remote storage entity;

inform the first remote storage entity regarding the indications;

assign sequence numbers to writes; and

send the sequence numbers to the first and second remote storage entities.

32. A redundant data storage arrangement comprising:

primary storage means for storing writes received from a host;

first remote mirror means for mirroring writes forwarded from the primary storage means and for tracking such writes via a first sidefile; and

second remote mirror means for mirroring writes forwarded from the primary storage means and for tracking writes such writes via a second sidefile;

the first and second storage entities having different levels of write-currency relative to each other;

the first sidefile including (1) sequence numbers assigned to writes and (2) acknowledgements from the second remote mirror means;

the second sidefile including sequence numbers assigned to writes;

comparison means, responsive to the primary storage means being rendered inoperative, for comparing the first and second sidefiles, and

update means, responsive to the comparison, for updating writes stored at the second remote mirror means based upon the comparison of the first and second sidefiles.

33. (canceled)

IX. EVIDENCE APPENDIX

None.

X. RELATED PROCEEDINGS APPENDIX

None.